April 1998 Highlights of the Pulsed Power Inertial Confinement Fusion Program

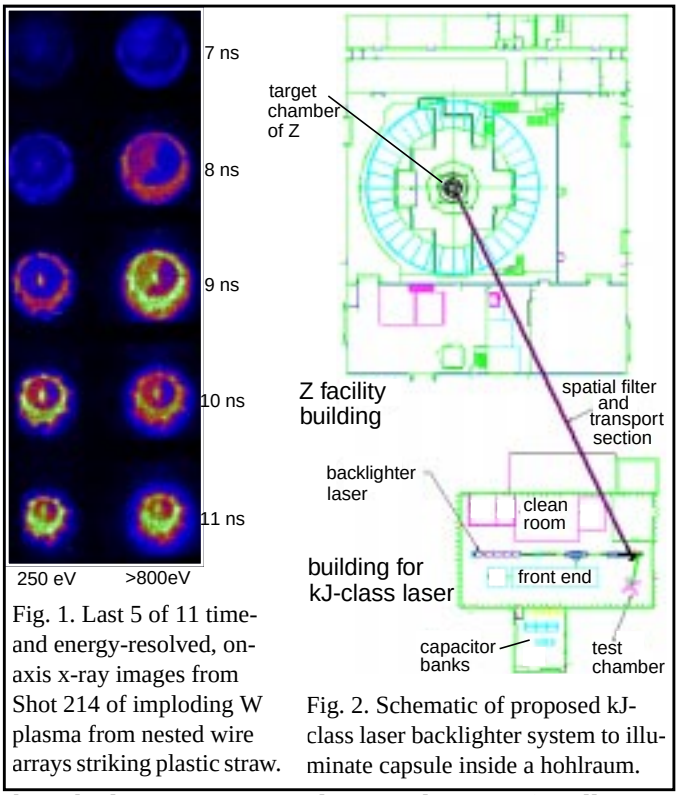

Fig. 1. Last 5 of 11 time- and energy-resolved, on-axis x-ray images from Shot 214 of imploding W plasma from nested wire arrays striking plastic straw.

Fig. 2. Schematic of proposed kJ-class laser backlighter system to illuminate capsule inside a hohlraum.

A meeting was held at Sandia with LANL and LLNL participation to prepare for a three-day May workshop in Las Vegas on use of fast (Saturn, Z) and slow (Pegasus, Atlas) pulsed power for stockpile stewardship. Hohlraum designs for the proposed X-1 were presented, as well as the power flow, z-pinch source, diagnostics, and hohlraum performance on Z (Fig. 1), based on data analysis, 2D simulations, and analytic modeling. The newest Z result reported was a vacuum hohlraum temperature of 150 eV for a very small gap (1.5 mm) between the hohlraum wall and the outer edge of the wire array compared to an original, conservative 5-mm gap. Even the 1.5-mm gap does not close--that is, short out and cause energy to reflect back toward the source. Previous vacuum hohlraum shots had 2-3 mm gaps, and dynamic hohlraum shots have had 3-5 mm gaps. A lower inductance (smaller gap or shorter array length) increases the energy coupled into x rays. The smaller gap also decreases radiation losses.

We had 19 Z shots this month: 8 to optimize the temperature in a vacuum hohlraum, 2 with a secondary hohlraum attached to a vacuum hohlraum for shock physics measurements, 4 to measure voltage and current in the pulse-forming, vacuum insulator, and load sections, a dynamic hohlraum shot with a less-massive inner wire array, and 4 weapons physics shots. Three of the vacuum hohlraum optimization shots were at the highest electrical charge tried yet (95 kV per module) in order to increase the current delivered to the wire array; the electrical charge used on other Z shots, aside from the earliest shots, has been 90 kV per module.

We are using the view-factor code, Lightscape^{TM}, to determine radiation transport efficiency between a primary and a secondary hohlraum in designing Z experiments. The 3D radiosity (for treating diffuse reflection) and ray-tracing (for specular reflection and transparency) code has been used by architects, interior designers, and in computer animation. Lightscape incorporates adaptive mesh refinement techniques that allow a greater-spatial-resolution, iterative solution compared to traditional view-factor codes and direct comparison to framing camera images from Z.

LLNL and SNL completed a conceptual design for a kJ-class, ns-scale, 50-μm-spot-size laser backlighter on Z that would use decommissioned components of Nova and Beamlet. Target imaging needs are up to 30 PW/cm^2 for point projection with 4 - 12 keV x rays and < 0.3 PW/cm^2 for area backlighting with 1 - 3 keV x rays. The estimated cost, including construction of a clean room for the laser in an existing building adjacent to Z (Fig. 2), is $10.8 million. The expected operating date is June 2000. Laser supports would be vibrationally isolated from the foundation and frequency conversion done before transport to the target chamber because of the mechanical shock generated by Z.

Active lithium ion source experiments on SABRE began again in late March following six weeks to repair the laser oscillator and decrease laser transport losses. Discharge cleaning of the LiAg anode, together with a higher magnetic field, reduced proton contamination of the lithium by a factor of 20, to 50 A/cm^2, and improved the azimuthal uniformity of the ion beam, but oxygen or carbon contaminants still dominate. Enhanced discharge cleaning and in-situ lithium deposition are being pursued to eliminate these heavy ions. A third laser amplification stage was added that will increase the fluence to 0.5 - 0.8 J/cm^2 and allow laser beam smoothing with a diffuser optic. This will mitigate hot spots that limit the ion source uniformity and exceed optical damage thresholds. A final, fully-integrated set of experiments will occur in June to late August before SABRE personnel pursue post-ion-project tasks.

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